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# RECENT PROGRESS IN PETROLEUM TECHNOLOGY AND THE PROBLEM OF THE DEVELOPMENT OF REFINERIES

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# RECENT PROGRESS IN PETROLEUM TECHNOLOGY AND THE PROBLEM OF THE DEVELOPMENT OF REFINERIES

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## 1. Recent progress in petroleum technology and some future problems.

a) Among the industries which have most developed in the last 5o years, the oil industry was in the foreground. In the power balance of countries with a highly developed industry, crude oil and natural gas represent today a share exceeding 50%. The recent progress achieved in processing technique by transforming crude oil into products which are widely employed in the conditions of modern life, such as plastics, rubber, fertilizers and others, has still more increased the interest in crude oil.

i) Keeping in mind the fact that on world level the annual total rate of power increase is of about 3%, the present world crude oil production of 1,1 thousand million tons will increase by 1975 to about 2 thousand million. The appearance of new sources in power balance, such as the nuclear, solar and other powers, we reckon that they will not be in a position in the next 3o to 4o years to change to a great extent the importance of liquid fuels, because of investments and of the time necessary for the development of new possibilities of utilization.

ii) Referring to the future demands for oil products, a greater decrease for residual fuels and kerosene, a slight reduction for explosion motor fuels amd a more important increase for fuels and liquified gas, may be expected.

b) It is to be expected that qualitatively improving the characteristics of products which may be profitably obtained will be continued. With gasoline besides the octane number which still remains a principal objective, due to the present trend of increasing the compression ratios, further improvements will certainly be achieved with regard to sulphur and gas contents, volatility, proportion of hydrocarbons, etc.

i) The attention given in the last few years to the production of jet fuels will be accentuated in the future, with a view to realizing higher characteristics, regarding congelation, fumigation point, distillation and stability. For liquid fuels in general , future trends will be directed towards obtaining better characteristics by decreasing the olefines, sulphur and ash contents and by greater chemical stability.

c) Obviously all modifications which will be made regarding the kind and quality of fuels, will be based upon the future development of power generators. Among the internal combustion engines, engines working on the Otto cycle will probably be employed in the next 15-2o years, with modifications improving their present technical characteristics. With Diesel engines, the development of which is still going on, improvements in construction are expected to be obtained which, besides the realization of higher performances, will make it possible to consume fuels of wider specifications. As regards the new types of power generators, an extension of gas-turbine motors, used in aviation, road machines and of free-piston motors for fixed installations is expected.

The principle objective in the construction of new types of engines is to obtain better performances and the possibility to consume cheaper fuels of less severe specification than the present ones.

d.) Crude oil refineries had to closely comply with the demands of fuel consumers, and this requires a continuous improvement of processing methods from the simple process of physical separation by groups of crude oil into hydrocarbons, to complex, chemical processes of structural molecular modification, especially by catalytic methods.

e.) With primary refining methods, the technological performances have been improved by the use of better heating and fractionating equipment, by combined large capacity installations and by automation, thus realizing savings of investments and of running expenses at the same time chemical and electrical treatment of crude oil, resulted in longer service cycles of refining equipment.

f.) In refining products, catalytic hydrogenation methods and electrical treating have been extended, and improvements in extraction methods by selective solvents have been achieved.

g.) The turning to account of residual products remains an important aim in the refining of crude oil, and, besides the known methods of thermo-cracking and coking, the recent appearance of hydrocracking, offering the advantage of great flexibility, will contribute to solving this problem. The high hydrogen consumption supplied at the present time, in a great proportion by catalytic reforming will have to be provided by independent means and at a low price.

h.) Regarding the catalytic processes for production of gasoline, catalytic cracking has, in some countries, exceeded 40% of crude oil refining, and in the following years will probably occupy a still more important place, so long as the present demand for light products will be maintained at the present level.

i.) In recent years, catalytic reforming has had the widest extension due to the performance achieved in increasing the octane number, and to the production of aromatic hydrocarbons, attaining about 20% of the refined crude oil. This method is in full progress due to the advantages offered. Among other catalytic methods which have lately been applied in crude oil refineries, and have development prospects in the future, has been the normal isomerization of paraffins, for the production of components with high octane numbers.

The large possibilities of petrochemistry have determined important modifications in the refining technique, and it is expected that in the future such modifications will be obtained at a growing rate. Thus metaxyle isomerization plants have been set up in refineries, for the production of ortho and paraxylon and of hydrodealkylation of alkylnaphtalenes and of toluene for obtaining petrochemical naphthalene and benzene.

j.) The list of petrochemical products is long and is continually becoming longer and by a realistic estimation, in 1965 it will come to more than 40% of the entire chemical industry. At present nearly 70% of the rubbers and over 85% of the aliphatic chemicals are produced from oil and natural gas, while certain products such as isoprophylic alcohol, butadiene and methylformaldehyde are obtained exclusively from crude oil. The numerous examples which may be given show the importance of crude oil for the industry.

2. Rumania's experience in the development of the crude oil refining industry related to the development of extraction and to the requirements for high quality refinery products

a) Rumania is among the first oil producing countries of the world.

The occurence of crude oil and its utilization for various purposes is known from documents dating prior to the XVth century, its organized exploitation , however started only much later, and in 1957, the Rumanian People's Republic celebrated the 100th anniversary of its oil industry. This long-standing activity has meant a rich experience in the extraction and refining of crude oil and has created a strong tradition within this industry.

a) The Rumanian crude oil production, which in 1936 amounted to 8,7 million tons/year decreased until 1944 to 3,6 million tons, due to the exploitation in poor technical and economic conditions, and to destructions caused by war. During that period of a total of 59 petroleum refineries only 12 had adequate technical equipment and the remainder were working in rudimentary conditions. A large quantity of crude oil was exported as such.

b. After the second world war by its passing into state property, the oil industry, reorganized on new bases and endowed with up-to-date technical equipment is characterized by an accelerated development in the framework of the planned development of the whole national economy. In the oil processing sector the principal objectives have been the rebuilding of refineries destroyed by war, and their concentration of refining into great production units, their territorial repartition according to the industrial development, the supply of refineries with modern refining system and the raising of economic efficiency in crude oil refining.

i. In the first stage new refining centres were set up, existing refineries were rebuilt and their capacity increased in view of the steady raise of the production level, and smaller refineries with low production and economic capacities were shut down. The second stage is characterized by the endowing refineries with the most up-to-date methods and equipment in order to obtain new high quality products, and for the development of petrochemistry. For the production of lubricating oils new, large capacity, complex plants for selective solventation were built, thus increasing the yearly output of lubricants of high viscosity index. The turning to account of residual products has been realized by coking methods, viscosity reduction and hydrocracking, especially concerning the production of medium distillates and fuels for Diesel engines, and by hydrofyning plants for improving the quality of these products. Due to these results the percentage of residual products decreased from over 40% in 1938 to about 25% at present, while the percentage of motor fuel increased from 12% to over 25%. Among catalytic methods for increasing the octane number, catalytic cracking plants of the liquid type ,and large catalytic reforming plants for the production of high quality gasoline and individual $C_6$, $C_7$ and $C_8$ aromatic hydrocarbons, were set up. The non-economic aspect until 1948 of crude oil refining based on the consumption of refinery gas, was solved by supplying the refineries with gas recovery and fractionating equipment, and the utilization of the refinery gas for petrochemistry or domestic purposes.

c. The introduction of new methods for improving the quality of products has brought about an increase of the octane number of 25-3o points in fuels for engines while the viscosity index of lubricating oils has increased from about 4o to more than 90 DD. Likewise, the quality of gasolines and fuel oils has been improved by decreasing their sulphur content and by increasing their chemical stability; congelation points of lubricants and of fuels went down, and generally, the competitive value of all products increased.Simultaneously with the deepening of crude oil refining , the production of special products has been extended, such as naphtenic acids, surfactants additives for fuels, lubricants, mercaptans, cresilic acids, wood impregnation fluids, etc. Due to rational refining of crude oil, the economic efficiency of that industry has increased; in a period of 6 years an increase of over 40% of its value has been achieved, while labour productivity increased by more than 25% as compared to the past.

i) At the same time with the development of crude oil refining, a great petrochemical industry has been created in Rumania, by the setting up of combined works for the production of synthetic rubber, plastics, synthetic threads and fibres and other products.

d) The difficulties, encountered immediately after the war in the realization of the reconstruction and modernization plan of the refining industry, due to the lack of a metallurgical and engineering industry for refinery equipment, have been solved by commissioning some works, endowed with modern technical equipment. As compared to the past, when Rumania had to import most of its refinery equipment, at the present time the production of our oil industry equipment engineering works set up in the period of socialist industrialization supplies the internal necessities, and an appreciable tonnage remains for export to other countries. In the post-war period, in order to assist the oil industry, research institutes and specialized laboratories for the study and experimenting of new crude oil refining and petrochemical problems as well as designing organizations have been established. For training petroleum engineers, an institute for higher training was set up, including all technical specialities required by the oil and gas industry, while for the training of lower technical refinery personnel, schools for technicians with refining as speciality were also established.

e) The improvement in working and living conditions for workers, one of the main concerns of the Rumanian state, has limited the working hours and has created the possibility for workers of spending their leisure hours in spas and health resorts or in sanatoriums. Special attention is given to labour protection and to safety technique, for increasing labour safety and reducing the number of accidents at work.

### 3. Considerations concerning the technical and economic conditions which permit to evaluate the possibilities of petroleum refineries

a) The construction of refineries in countries with oil deposits is an essential condition for their economic development, based on a rational turning to account of the resources at their disposal. For developing countries, it is advisable that the setting up of refineries be attentively correlated to current consumption requirements of oil products, to probable requirements for the following years, for internal and international markets, to the specific industrial development possibilities and to requirements of the raising living standard of the population. In drawing up plans for the construction of refineries in countries with a developing industry, the study of conditions connected with possibility of uniformly supplying refineries with sufficient quantities of raw materials, is necessary. We also consider it advisable that possibilities be kept in mind of setting up refineries with large capacities, which should be in position to turn out a range of products required by the sectors consuming fuels, gasolines, fuel oils, lubricants, Diesel fuels, as well as having up-to-date plants for coking, hydrofining, cracking and catalytic reforming, in order to ensure the production of raw materials for other important industries, especially detergents, fertilizers, bases for insecticides, liquefied gas, road-bitumen, etc. Wherever local economic conditions impose it, the setting up of refineries may of course be realized in stages, providing from the beginning the facilities required for the final phase, in view of the economically satisfactory realization of auxiliary installations.

b) Regarding the siting of refineries, it is economically advisable that they be placed near the source of raw materials, or at distances from which raw materials may be economically transported, in regions with transport facilities, waterways, and in the vicinity of consumption centres.

For ensuring an economic siting, preliminary studies are necessary taking into consideration the most advantageous conditions and, at the same time, creating the possibility of making use of local resources, so as to reduce investments and exploitation expenses.

c) Labour necessary to the crude oil refining industry is an important problem, and the fact that special qualifications are required, makes it necessary that a sufficient number of workers, foremen and engineers be trained in time, in schools and in the factories existing in more advanced countries thus becoming able to take over the running control of the refinery, when the installation is completed.

i) Experience has shown that for medium and higher personnel, a practice of about 1-2 years is necessary , for mastering sufficiently the necessary knowledge.

ii ) In the case of a collaboration between countries for setting up refineries in countries which have no industries of their own, it seems advisable that this task be realized with the aid of the constructing country, which should facilitate the training of the necessary staff on the basis of certain theoretical and practical educational plans.

d) Regarding the possibility of setting up refineries in developing countries; the designing, delivery and mounting of equipment and putting the respective plant into commission, should be kept in mind in the general contracts between countries.

i) The method used sometimes of a single general contractor, has proved effective, this contractor bearing full responsibility for the entire installation, and being thus in a position to ensure the realization of the parameters stipulated in the design and the contract.

ii) In case there is no general contractor for the entire equipment, contracts may evidently be signed with various contractors from the same or from different countries, the construction of the refinery remaining in charge of the beneficiary country, the contractors giving technical assistance in mounting the refinery and putting it into commission. In this case, other tasks reverting to contractors should be the training of the exploitation staff, and the upkeepers of the equipment.

iii) Technical problems regarding designing, production of equipment, constructions, etc. should be provided for in accordance with international norms (I.S.O), or to other specified norms.

e) Construction terms for refineries , which represent a contractual obligation between contractors and beneficiaries are dependent on local conditions: experience has shown that the normal completion term for a refinery is of 22-30 months from the signing of the contract.

## 4. Rumania's realizations in other countries

a) By the discovery of new oil fields, at which the Rumanian People's Republic has also collaborated, the Indian state has accelerated the construction of state refineries at Gauhati and Barauni. The Gauhati refinery, with a yearly capacity of 750.000 tons, with an extension possibility to over one million tons entered into commission in 1962, was designed and constructed by Rumania, on the basis of bilateral agreements. For placing the refinery, establishing the capacity and treating profile, preliminary technical economic studies by Rumanian and Indian experts were necessary. To satisfy the local consumption of oil products and to ensure future industrial development were basic criteria for selecting the capacity and profile of the refinery. The technological scheme of the refinery comprises atmospheric distillation, coking, kerosene solventing with sulphur dioxide,

gas recovering and fractionating plants, and auxiliary installations for refining the products. The refinery has all auxiliary installations, such as tank farms, pumping stations, loading facilities, laboratories etc., as well as a thermo-electrical power station. The mounting of the refinery was carried out by Indian construction enterprises, and the putting into commission with the collaboration of Rumanian technical personnel.

i) The main difficulties encountered in the designing and construction of the refinery was the high seismicity of the region, the weak resistance of the ground, the industrial water supply and the evacuation of residual water, the rainfalls, specific to tropical regions, and the labour supply for construction.

b) The training of the Indian technical personnel for running of the refinery was the object of a special attention in the framework of Rumanian-Indian collaboration. Indian engineers and technicians were practically and theoretically trained, for more than two years, in Rumanian petroleum institutes and refineries, while Rumanian specialists sent to India have organized initiation courses regarding operative technique, maintenance and repairs, and the prevention of accidents in petroleum refineries.

## 5. Conclusion

By the development of oil industry on the line of using complex and complete technological processes, the possibilities of employing a still wider range of the products obtained are considerably growing and on the production of special high quality fuels, are ensured on the one hand and, on the other, a particularly important source of raw materials for the petrochemical industry is thus created. We consider that by such an orientation, countries in process of industrialization which possess crude oil deposits, will be in a position to develop powerful, natural oil and petrochemical industries, thus rationally turning to account an important source of raw materials.



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